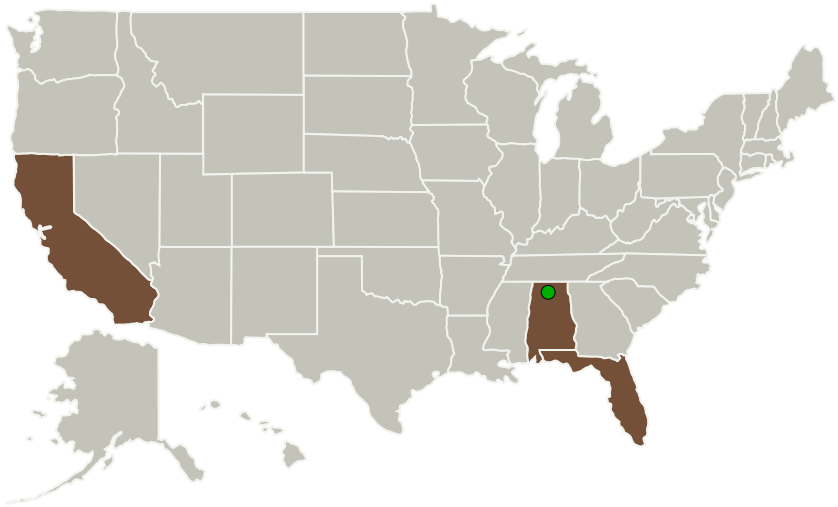
High Fidelity Tool for Turbulent Combustion in Liquid Launch Propulsion Systems Based on Spray-Flamelet Methodology, Phase II

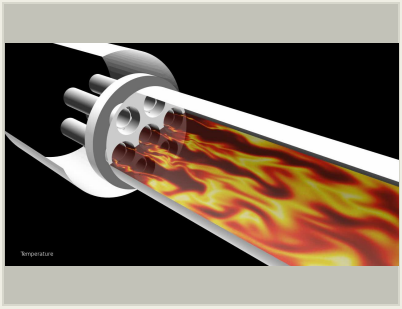
Completed Technology Project (2015 - 2017)

Project Introduction

The innovation proposed here is a high-performance, high-fidelity simulation capability for simulating liquid rocket spray combustion based on a novel spray-flamelet methodology which will be integrated into Loci-STREAM which is a CFD solver developed by the proposing personnel under funding from NASA over the last several years. A new spray-flamelet formulation will be incorporated into Loci-STREAM. The particular advantages of this formulation are (i) its consistency with the single-phase flamelet-formulation (already available in Loci-STREAM), (ii) its formulation in mixture-fraction space, overcoming the non-uniqueness of the classical mixture-fraction parameterization, and (iii) its applicability to finite Stokes-number, thereby accounting for particle evaporation, slip-velocity, and poly-dispersed spray-phase. The flamelet methodology already available in Loci-STREAM – in conjunction with Hybrid RANS-LES (HRLES) methodology – has facilitated an order of magnitude improvement in simulation turnaround times for NASA applications involving complex physics in 3D geometries. This project is aimed at extending this flamelet methodology to spray combustion resulting in a state-of-the-art design and analysis tool to enable accurate, fast and robust simulations of multiphase combustion in liquid rocket engines (involving liquid propellants such as LOX and LH2/LCH4/RP-1/RP-2), combustion stability analysis, etc. which constitute critical components of NASA's upper stage launch propulsion systems.

Primary U.S. Work Locations and Key Partners





High Fidelity Tool for Turbulent Combustion in Liquid Launch Propulsion Systems Based on Spray-Flamelet Methodology Project Image

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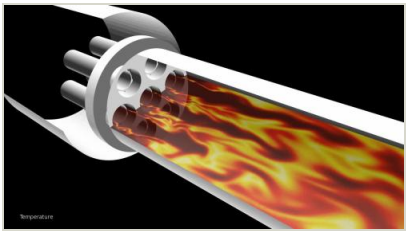
Organizations Performing Work	Role	Type	Location
Streamline Numerics, Inc.	Lead Organization	Industry	Gainesville, Florida
Marshall Space Flight Center(MSFC)	Supporting Organization	NASA Center	Huntsville, Alabama
Stanford University(Stanford)	Supporting Organization	Academia	Stanford, California

Primary U.S. Work Locations	
Alabama	California
Florida	

Images



Project Image
High Fidelity Tool for Turbulent Combustion in Liquid Launch Propulsion Systems Based on Spray-Flamelet Methodology Project Image
(https://techport.nasa.gov/image/134403)

Organizational Responsibility

Responsible Mission Directorate:
Space Technology Mission Directorate (STMD)

Lead Organization:
Streamline Numerics, Inc.

Responsible Program:
Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:
Jason L Kessler

Program Manager:
Carlos Torrez

Principal Investigator:
Siddharth S Thakur

Co-Investigator:
Siddharth Thakur

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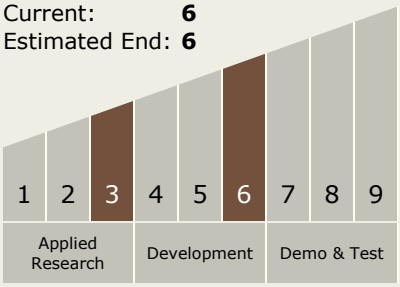
Technology Maturity (TRL)

Start: **3**
Current: **6**
Estimated End: **6**



Technology Areas

Primary:

- TX01 Propulsion Systems
  - TX01.1 Chemical Space Propulsion
    - TX01.1.3 Cryogenic

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System